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Detection of pole-like objects from LIDAR data

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Abstract

This paper presents novel approach for detection of pole-like objects from LIDAR data. The designed method uses directional vector to detect pole-like structures in unordered point clouds. A new segmentation algorithm is presented as well. The segmentation is designed to overcome a common problem found in LIDAR data of urban environments, where a lot of poles are connected together with various types of wires. The method is tested on real world point clouds captured during mobile mapping process.

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Keywords: point cloud; LIDAR; pole-like objects; poles detection; laser scanning; mobile mappings

1. Introduction

The laser scanning of the urban environment is a common task nowadays. The 3D point clouds are usually obtained using the vehicle mobile mapping. It is often required to automatically detect and classify various objects like roads, horizontal and vertical traffic signs, trees, street lights, crash barriers etc. The information about the detected object is used in various applications, e.g. road inventory. Various pole-like objects are in the forefront of interest. This paper is focused on the design of the novel method intended for automatic detection of pole-like objects, mainly electrical poles and street lightings, in the 3D point cloud data. The method is tested on the urban environment, where a lot of poles are connected together with various types of wires. This issue complicates the segmentation process.

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2. Related work

Pole-like object is an object which points (captured using LIDAR) are arranged in cylindrical shape and directing upwards (Pu et al., 2011). Each method for pole-like objects detection from LIDAR data is trying to detect this kind of structure.

Yokoyama et al. (2013) describes method which is based on classification of individual points. First, the ground points are removed. Second, the input point cloud is segmented and each segment is smoothed. After the smoothing is performed, each point is classified in one of three possible categories: pole points, points on a planar object and others (see Fig. 1). The pole points are classified based on an analysis of their neighborhood. If the neighborhood of the point is arranged in one (upwards) direction, the point is classified as pole point. In the last step, the segments are filtered based on their height, number of points and a number points classified as pole points. The result of the detection is a list of pole-like objects. The advantage of this method is the possibility of detection of other objects attached to the poles. The disadvantage is the need for very precise elimination of ground points and a very good result of the segmentation process.

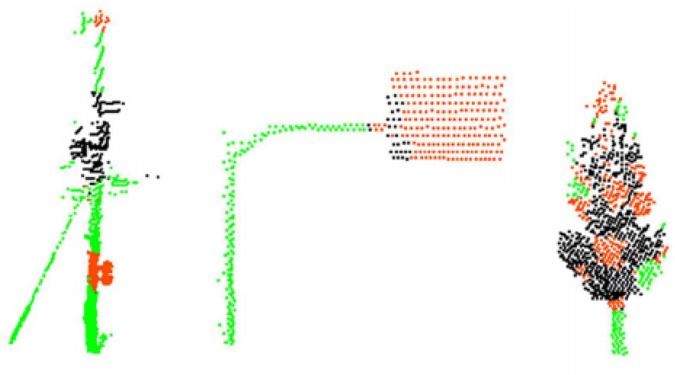

Fig. 1. The result of the point classification used in Yokoyama et al. (2013). The green color represents pole points, the orange color represents points on planar object and the red color represents other points.

Another method for pole-like object detection can be found in Ishikawa et al. (2013). The method is used to detect pole-like objects, walls and railings. The algorithm focuses on smaller parts of point clouds and includes SVM (Support Vector Machines). As in the previous approach, the first steps handle with ground points removing and solving segmentation problem. Authors point out very common over-segmentation problem, where one object is divided into smaller parts and the under-segmentation, where many different objects are placed in one segment. The problem of dividing point cloud into smaller parts is one reason of wrong detection of building edges as a pole-like objects. In order to avoid this issue, the authors also calculate the degree of point isolation from other objects.

Lehtomäki et al. (2010) designed a method based on scan-lines. Each scan-line is segmented individually and then the segments are placed on the top of each other (see Fig. 2). If one segment is directly over another one, then these segments are placed in one cluster. To mark a cluster as a pole-like object, it must fulfill following criteria:

- The cluster height must exceed specified threshold,
- The cluster must consists of 3 segments at least,
- The shape of the cluster must resemble cylindrical shape,
- The main axis of the cluster must be in upwards direction,
- There are no other points in a near vicinity of the cluster.

The authors specify around 80% successful rate of detecting pole-like objects.